Appendix 3.8-B

Summary of Hydraulic Modeling for Project Alternatives

Hydraulic Modeling

Preliminary hydraulic modeling was performed for the Kings River, Cross Creek and the Kern River using HEC-RAS River Analysis System program Version 4.1.0 developed by the U.S. Army Corps of Engineers (USACE) (Authority 2013a). The hydraulic modeling was conducted based on the 15% Design Submission of the structural drawings and 100-year peak flow information documented in FEMA flood insurance studies (FISs) (Table 3.8-B1). Changes in water surface elevations at the main channel on the upstream side of the HST alignment were evaluated based on the results of the hydraulic modeling.

Table 3.8-B1
100-Year Flow Rates from the Hydraulic Modeling

Waterway	Flow (cfs)	Alternative
Kings River Complex	19,900	BNSF Alternative, Hanford West Bypass alternatives
Cross Creek	19,200	BNSF Alternative, Hanford West Bypass alternatives
Kern River	10,200/15,000[a]	BNSF Alternative, Bakersfield South, and Bakersfield Hybrid

Source: Authority 2013a, Fresno to Bakersfield Section: Hydrology, Hydraulics, and Drainage Report.

Note:
[a] Central Valley Flood Protection Board 100-year peak flow.

Kings River

The BNSF Alternative would cross Cole Slough, Dutch John Cut, and the Kings River (collectively referred to as the Kings River Complex) approximately 3 miles east of the town of Laton. The BNSF Alternative would cross the Kings River Complex on an 11,680-foot-long elevated structure. The two levees on Cole Slough and the northern levee on Dutch John Cut are federal/State project levees maintained by the Kings River Conservation District (KRCD) under USACE agreement. There are no levees on the Kings River (Old River).

The Kings River moved from its original alignment during large storm events in 1861 and 1867. The main flow channel moved from its original alignment (Old Kings River) into Cole Slough, several miles upstream of the HST crossing. At the HST crossing location, the river returns to its original alignment through Dutch John Cut, which connects Cole Slough to the Kings River. At the proposed crossing, Dutch John Cut conveys the main flow of the Kings River Complex. The channel width of Dutch John Cut is approximately 600 feet from outside of levee to outside of levee at the crossing, and the main channel is approximately 100 feet wide. The channel width of Cole Slough is approximately 250 feet from outside of levee to outside of levee at the crossing, while the main channel is approximately 150 feet wide. The bank-to-bank width at the Kings River (Old River) crossing is approximately 500 feet, and the main channel is approximately 100 feet wide. The floodways designated by the Central Valley Flood Protection Board (CVFPB) for Cole Slough, Dutch John Cut, and the Kings River follow the defined channels of each waterway within the FEMA floodplain.

The current design concept of the elevated structure includes a foundation with 10-foot-diameter columns that are generally spaced 100 to 120 feet apart. The elevated structure would cross Cole Slough, Dutch John Cut, and Kings River (Old River) before transitioning to a 2,700-foot-long embankment in the southern portion of the Kings River floodplain. The northern abutment of the elevated structure is located to the north of the Cole Slough levee, outside of the Kings River

Complex floodplain. The southern abutment is located south of the Kings River (Old River) channel. Four segments of the elevated structure are truss bridges. One truss bridge crosses over Cole Slough with a 360-foot-long single span. The second truss bridge crosses over Dutch John Cut with two spans of 360 feet each and a two-column pier located in the overbank area on the north side of the main channel. The third truss bridge crosses over the Kings River channel immediately downstream of an existing earthen low-flow crossing, with two spans of 320 feet each and a two-column pier located in the main channel. The fourth truss bridge is a single-span bridge of 320 feet in length that crosses over Riverside Ditch.

A FEMA 100-year flow of 19,900 cubic feet per second (cfs) was used for the Kings River floodplain hydraulic modeling. This 100-year flow was obtained from a FEMA FIS for Tulare County, California, and Incorporated Areas, dated June 16, 2009. For the FEMA 100-year flood modeling at the Kings River Complex, the analysis covers the existing FEMA floodplain width, extending from approximately 4,700 feet upstream of the crossing to approximately 1 mile southwest of the town of Laton. These limits were used because they encompass the area where topographic mapping and the 100-year peak flow information are available. The maps used for the HEC-RAS modeling of the floodplain consist of Project topographic maps and LiDAR maps for areas outside the Project topographic maps.

The HEC-RAS modeling results are summarized in Table 3.8-B2. Under the FEMA 100-year peak flow, the proposed crossing would cause less than a 0.1-foot rise in the water surface elevation (WSE) of the floodplain. At the proposed truss bridges, clearances of around 20 feet would be maintained between the 100-year WSE and the bridge soffit at the three channels of the Kings River Complex.

Table 3.8-B2
Modeling Results for the Kings River Complex

Alternative	Modeled Flow (cfs)	WSE - Existing Condition (feet)	WSE - Proposed Condition (feet)	Increase in WSE (feet)
BNSF Alternative	19,900	270.58	270.59	0.01

Source: Authority 2013b.

Acronyms and Abbreviations:
cfs = cubic feet per second
FIS = flood insurance study
WSE = water surface elevation

The Hanford West Bypass alternatives would cross the Kings River approximately 0.6 miles west of the town of Laton. The Kings River would be crossed on an 8,520-foot-long elevated structure. At the proposed crossing, the channel width of Kings River, from outside of levee to outside of levee, is approximately 1,625 feet, while the main channel is approximately 400 feet wide. The main channel would be crossed at an approximate 80-degree angle. The two levees on Kings River are federal/State project levees maintained by the KRCD under USACE agreement. The CVFPB-designated floodway at the Kings River follows the defined channel of the waterway.

A FEMA 100-year flow of 19,900 cfs was used for the Kings River floodplain hydraulic modeling. This 100-year flow was obtained from the FEMA FIS for Tulare County, California, and Incorporated Areas, dated June 16, 2009. The hydraulic modeling covers the existing FEMA floodplain width, extending from approximately 4,700 feet upstream of the BNSF Alternative to approximately 6,300 feet downstream of the Hanford West Bypass alternatives. The maps used

for the HEC-RAS modeling of the floodplain consist of Project topographic maps and LiDAR maps for areas outside the Project topographic maps.

The HEC-RAS modeling results are summarized in Table 3.8-B3. Based on the hydraulic analysis, the HST impact on the 100-year WSE would not be substantial (less than 0.1 feet).

Table 3.8-B3
Modeling Results for the Kings River

Alternative	Modeled Flow (cfs)	WSE - Existing Condition (feet)	WSE - Proposed Condition (feet)	Increase in WSE (feet)
Hanford West Bypass alternatives	19,900	259.11	259.12	0.01

Source: Authority 2012.

Acronyms and Abbreviations:
cfs = cubic feet per second
WSE = water surface elevation

Cross Creek

The BNSF Alternative and Hanford West Bypass alternatives intersect Cross Creek approximately 5 miles north of the city of Corcoran, within the vicinity of the existing BNSF Railway. All of the alignments would traverse Cross Creek on an aerial structure and pass over the main channel on a single steel truss span. The crossings would occur at an approximate 45-degree angle. The width of the Cross Creek channel from outside of levee to outside of levee is 220 feet.

Cross Creek levees are maintained by the Cross Creek Flood Control District. However, these levees are not certified for urban protection and therefore according to FEMA they do not provide urban-level flood protection. Therefore, the FEMA FIS and digital flood insurance rate map (DFIRM) for Cross Creek do not take the levees into consideration.

A CVFPB and FEMA floodway as well as a FEMA floodplain are delineated at Cross Creek. The FEMA-designated floodplain is about 5 miles wide at the crossing. The FEMA-designated floodway is approximately 1,800 feet wide on the upstream side of the existing BNSF Railway, narrows to fit under the existing BNSF bridge across the main channel (250-foot bridge), and then widens on the downstream side to about 800 feet. There are also several smaller openings in the BNSF Railway embankment to the north and south that appear to pass flood flows. The CVFPB-designated floodway is about 1.5 miles wide at the crossing.

The FEMA 100-year flow of 19,200 cfs was used for the Cross Creek floodplain hydraulic modeling. This FEMA 100-year flow was obtained from the FEMA FIS for Kern County, California, and Incorporated Areas, dated June 26, 2008. The maps used for the HEC-RAS modeling of the floodplain consist of Project topographic maps. Channel bottom elevation was adjusted based on the profile information documented in the FEMA FIS report dated September 26, 2008.[1] The most upstream cross section of the hydraulic modeling was located approximately 2.5 river miles upstream of the BNSF Railway. The most downstream cross section was located approximately

[1] Based on a comparison of the structure information, it was found out that the FIS report elevations are approximately 10 feet higher than the Project mapping elevations. The profile elevation information from the FIS report was reduced 10 feet for use in the HEC-RAS modeling.

2,400 feet downstream of the BNSF Railway. Most of the cross sections extend over the FEMA floodplain.

The HEC-RAS modeling results are summarized in Table 3.8-B4. Since the Cross Creek channel (with levees on both banks) has a flow conveyance capacity that is much smaller than the 100-year peak flows, split flows from the channel were modeled separately to obtain the potential water depth in the channel as well as the water depth on the floodplain and floodway (i.e., the main channel, right overbank, and left overbank were modeled separately). The modeling results show that there would not be a substantial change (less than 0.1 feet) in the water surface elevations at Cross Creek for the alternatives.

Table 3.8-B4
Modeling Results for Cross Creek

Alternative	Modeled Flow (cfs)	WSE - Existing Condition (feet)	WSE - Proposed Condition (feet)	Increase in WSE (feet)
BNSF Alternative (Alignment K3)	8,897 (Left Overbank)	200.33	200.29	0.04
	2,826 (Channel)	199.36	199.33	0.03
	7,477 (Right Overbank)	199.46	199.43	0.03
BNSF connecting to Corcoran Bypass or Corcoran Elevated (Alignment K4)	8,052 (Left Overbank)	200.28	200.26	0.02
	2,917 (Channel)	199.83	199.76	0.07
	8,232 (Right Overbank)	199.65	199.56	0.09
Hanford West Bypass 1 (Alignments K2 and K6)	8,946 (Left Overbank)	195.35	195.29	0.06
	2,716 (Channel)	198.42	198.42	0.00
	7,538 (Right Overbank)	198.19	198.17	0.02
Hanford West Bypass 2 (Alignments K1 and K5)	8,750 (Left Overbank)	200.33	200.3	0.03
	2,911 (Channel)	198.75	198.75	0.00
	7,539 (Right Overbank)	199.42	199.4	0.02

Source: Authority 2013c

Acronyms and Abbreviations:
cfs = cubic feet per second
WSE = water surface elevation

Kern River

The BNSF Alternative, Bakersfield South Alternative, and Bakersfield Hybrid Alternative would cross the Kern River on an elevated structure. The aerial structure would cross over Kern River at a 30-degree angle. The CVFPB-designated floodway and the FEMA-designated floodplain follow the defined Kern River channel. The FEMA floodplain is generally confined by the north bank of Gates Canal and the south bank of Cross Valley Canal within the Project vicinity.

There is a local (city of Bakersfield) combination flood control levee and recreation trail along the south bank of the Kern River at the proposed HST crossing. Any structural encroachments, modifications, or intrusions to this levee would be avoided (Authority 2013d).

Both FEMA and CVFPB 100-year peak flows were used for the hydraulic modeling. The FEMA 100-year flow of 10,200 cfs was obtained from the FEMA FIS for Kern County, California, and Incorporated Areas, dated June 26, 2008. The CVFPB 100-year peak flow of 15,000 cfs is from the CVFPB Designated Floodway Program, dated September 6, 1990. The most upstream cross section is located approximately 1,270 feet upstream of the BNSF Railway. The most downstream cross section is located approximately 400 feet upstream of Coffee Road. Most of the cross sections extend over the FEMA floodplain, which is close to 4,000 feet in width at the widest location within the Project vicinity.

The HEC-RAS modeling results are summarized in Tables 3.8-B5 and 3.8-B6. The modeling was done for the following two scenarios: the lower dirt road embankment adjacent to the north bank of the Kern River from Coffee Road to Mohawk Street would not fail during a 100-year flow and the lower dirt road embankment would fail during a 100-year flow. The proposed BNSF Alternative would cause less than a 0.23-foot rise in the channel for either the FEMA 100-year flow or the CVFPB 100-year flow, while Bakersfield South and Bakersfield Hybrid alternatives would cause less than a 0.42-foot rise in the channel for the FEMA 100-year flow and up to a 0.56-foot rise in the channel for the CVFPB 100-year flow.

Table 3.8-B5
Modeling Results for the Kern River When Road Embankment Does Not Fail

Alternative	Modeled Flow (cfs)	Location	WSE - Existing Condition (feet)	WSE - Proposed Condition (feet)	Increase in WSE (feet)
BNSF Alternative (Alignment B1)	10,200	B1 Sta. 7989+79	391.47	391.62	0.15
		Upstream BNSF Bridge	394.11	394.21	0.10
	15,000	B1 Sta. 7989+79	393.25	393.40	0.15
		Upstream BNSF Bridge	396.02	396.17	0.15
Bakersfield South and Bakersfield Hybrid (Alignments B2 and B3)	10,200	B3 Sta. 7094+94	392.19	392.25	0.06
		Upstream BNSF Bridge	394.11	394.44	0.33
	15,000	B3 Sta. 7094+94	393.95	394.00	0.05
		Upstream BNSF Bridge	396.02	396.48	0.46

Source: Authority 2013e

Acronyms and Abbreviations:
cfs = cubic feet per second
Sta. = Station
WSE = water surface elevation

Table 3.8-B6
Modeling Results for the Kern River When Road Embankment Fails

Alternative	Modeled Flow (cfs)	Location	WSE - Existing Condition (feet)	WSE - Proposed Condition (feet)	Increase in WSE (feet)
BNSF Alternative (Alignment B1)	10,200	B1 Sta. 7989+79	391.44	391.60	0.16
		Upstream BNSF Bridge	394.11	394.22	0.11
	15,000	B1 Sta. 7989+79	392.89	393.09	0.20
		Upstream BNSF Bridge	395.91	396.03	0.12
Bakersfield South and Bakersfield Hybrid (Alignments B2 and B3)	10,200	B3 Sta. 7094+94	392.16	392.32	0.16
		Upstream BNSF Bridge	394.11	394.52	0.41
	15,000	B3 Sta. 7094+94	393.64	393.85	0.21
		Upstream BNSF Bridge	395.91	396.39	0.48

Source: Authority 2013e

Acronyms and Abbreviations:
cfs = cubic feet per second
Sta. = Station
WSE = water surface elevation

References

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